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Heavy Metal Lead in Filipino Staple Food as Studied in Metro Manila, Philippines

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Abstract

Rice and fish are the staple food for Filipinos. The global environmental condition has continually been deteriorating. Metro Manila, Philippines showed heavy metal contaminations in air, water, plants and soil which could pollute rice and fish. Lead is hard to biodegrade hence may accumulate in the biologic system leading to neurologic deficits particularly among children. From the results obtained using Flame Atomic Absorption Spectrophotometry (FAAS), all rice varieties and fish samples showed the presence of lead. Only regular Malagkit and NFA rice went above while all kinds and parts of fish went beyond the allowable limit for lead in food. The projected blood levels also went beyond the safe limit of lead in relation to fish consumption in both children and adults. However, in relation to rice consumption all of the projected blood lead exceeded the allowed limit only among children. The projected blood lead in adults exceeded the safe limit with rice consumption of only four varieties.

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1. Introduction

1.1. Background of the Study

Metro Manila, Philippines is the seat of the country's urbanization. Pioneering studies of the author in the previously mentioned area for the past few years, showed that the soil, plant leaves, rain water, air [1] and water in general [2] are contaminated with lead. Human activities highly contribute to heavy metal presence

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in the environment. Lead is a principal environmental contaminant since it can be distributed in different components of the earth. At extremely elevated concentration, this metal, poses a threat to living organisms [3].

Rice and fish are staple food for Filipinos. With lead contamination in the Metro Manila environment, agricultural and aquatic products as rice and fish respectively are most likely to be polluted. Vegetables [4], fruits [5] and shells foods [4] from another set of baseline studies by the author in the said area showed heavy metal contaminations. Heavy metals are hard to biodegrade and thus stay long in the environment. Lead attacks the bone marrows, and the peripheral and central nervous systems on chronic exposure. It causes neurologic deficit. Adults, absorb around 20-30% of the heavy metal on ingestion while children absorb up to 50% [6].

1.2. Objectives of the study

This study in general aimed to determine if rice and fish samples from Metro Manila, Philippines contain lead. Specifically, this study aimed to determine if the lead levels in rice and fish went beyond the acceptable limits for food set by the US Environmental Protection Agency. Also this study aimed to determine whether levels of lead in the different fish sample parts were significantly different from each other or not. Further it aimed to calculate the projected blood lead levels in children and adults based on the amount from the samples and compare it with the safety limit set by the Center for Disease Control.

1.3. Scope and limitation of the study

This study focused on randomly selected ten varieties of rice and ten kinds of fish only, marketed in Metro Manila, Philippines. For the fish, only its head, meat and mixed internals were prepared and analyzed. Flame Atomic Absorption Spectroscopy was used for the heavy metal analysis.

1.4. Significance of the Study

The results of this study will benefit the general Filipino public as it will give them general information on the best varieties of rice and kinds of fish to consume in relation to lead contamination. This will also hopefully aide in the cleanup of the environment specifically soil and water in order to lessen lead pollutants in consumer goods. Improved processing of rice and fish may also be initiated by agencies in the Philippines related to food.

2. Methodology

2.1. Research design

This study followed descriptive exploratory design. The actual amounts of lead from the collected samples were explored and its acceptability in relation to standard limits were assessed. Also the projected blood levels for both adults and children were calculated to describe the possible amounts of lead that may be absorbed by the body.

2.2. Locale of the study

The wet laboratory portion of the study was conducted at the University of the Philippines, Manila. Samples were collected from markets in Metro Manila, Philippines. The lead content of the samples was analyzed at the Dela Salle University, Manila.

2.3. Sample Collection

Ten varieties of rice and ten kinds of fish were randomly collected from markets in Metro Manila,

Philippines during the cold, dry season of 2011. The cooked rice samples and raw fish, prior to preparation for analysis were stored in the refrigerator at the University of the Philippines, Manila.

2.4. Sample preparation

To 5 g of each sample, 10 mL nitric acid was added. These were left overnight for pre-digestion. The samples were then heated using a water bath maintained at 80-100°C for 5 hours, cooled, filtered and filled with distilled water to volume in a 50 mL volumetric flask. The samples were transferred and stored in polyethylene bottles prior to Flame Atomic Absorption Spectrophotometry (FAAS)[7].

2.5. Heavy metal analysis

The lead levels were analyzed using Flame Atomic Absorption Spectrophotometer (AA-6300, Shimadzu, France) controlled by a personal computer using WizAArd software. Measurements were carried out at 217.0 nm with 0.7 nm low slit and 5 mA electric current [8]. The instrumental analysis was done at the Chemistry Instrumentation Laboratory of the De La Salle University, Taft Avenue, Manila. Lead concentration levels were expressed in mg/kg unit

2.6. Data Analysis

The data obtained were analyzed in comparison with the Allowable Standard Limits set by US EPA and ATSDR to water and food respectively. The blood lead levels were projected based on the 50% and 30% absorption capability of children and adults respectively, for lead. The starting amounts were based on the determined actual lead concentration in the samples studied

3. Results and Discussion

Rice is being eaten by every Filipino family at least three times a day. Fish is the regular viand of Filipinos as the Philippines is basically made of island clusters. Chemical contaminants like lead that may be present in rice may accumulate in the bodies of Filipino adults and children. Since children absorb lead more at 50% than adults at 20-30% [6] and have less mature organ systems, the possibility of intoxication with the heavy metal is higher. The adults, however, are not free from lead's adverse effects.

From the analysis made of the ten varieties of rice, all contained heavy metal lead but only two went beyond the acceptable limits of lead in food at 0.5ppm [9]. These were the regular malagkit and the National Food Authority (NFA) rice brands. The latter is the cheapest and least processed brand in the Philippines.

The projected blood levels of lead in children on all brands tested showed amounts greater than the safety limit set by the Center for Disease Control at 10µg /dL [10]. NFA rice showed the highest projected blood levels of lead followed by regular Malagkit and then Dinorado. The varieties NFA, Malagkit (regular), Dinorado and Malagkit (violet) went above the safety limit of lead in blood as projected, in relation to adults (Table 1).

The Philippines being a country surrounded by water bodies, have fish as the staple viand of its people. Whole fish are usually cooked and eaten per meal particularly the meat of the body. The head and internal organs are used for special menus yet these same parts are sometimes given to pet animals like cats. The lead levels of fish and its parts then must be determined to assess the safe levels of consumption of the Filipino population.

In general, all of the fish part samples across the different kinds of fish collected on the cold, dry season in the Philippines, showed levels of lead beyond the acceptable limits set at 0.5ppm for lead in food and 10ug/dL for lead in blood for both children and adults (Tables 2,3,4). These are all sellable kinds of fish in the Philippines. Janitor fish however is not a regular fish dish. It was included since some Filipinos are extracting fish sauce from it. They wish to find good use for it since it is becoming a problem especially in Marikina

Rivers. A similar study on fish, with collection done on the rainy season of 2012, by the author and other coauthors, showed results within acceptable limits of lead in the samples. Only tilapia, galunggong, dalagang bukid and matambaka were the similar kinds of fish in both studies [11]. Though not explored in the study area yet, it could be that seasonal variation may alter lead concentration in fish species due to movement of water and fish particularly during the rainy months in the country.

By using one way ANOVA, it showed that the lead amounts in the different parts did not differ from each other significantly (Table 5). Filipinos then would get equally the same amount of lead in meat, head and internals of fish. Pet animals will also be contaminated with the said heavy metal once given fish parts as food.

4. Conclusions

Based on the results of this study, rice varieties and fish kinds marketed in Metro Manila Philippines contain heavy metal lead as collected on cold, dry season in the Philippines. Of the ten rice samples, only regular Malagkit and NFA rice showed values beyond the acceptable limits set by US EPA. All of the projected blood levels for children went beyond the safe limits set by the Center for Disease Control but for adults only four varieties namely, NFA, Malagkit (regular and violet) and Dinorado rice gave projected blood values beyond the limit. All fish samples showed lead amounts beyond that which is acceptable for food and blood for both children and adults. There is no statistically significant difference in lead amounts in different fish parts across the kinds analyzed.

5. Recommendations

It is recommended to do similar studies to other rice varieties and fish kinds preferably in varied Philippine seasons, in order to assess the Filipino staple food's safety. Improvement of food processing should be looked into especially for rice in order to further lessen lead contamination. Environmental –soil and water body clean-up must be initiated. The sources of lead contaminants must also be definitely identified for proper legal actions by the Philippine government.

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Table 1. Mean Lead Levels of Ten Rice Varieties with Projected Blood Lead Levels

Rice	Concentration (ppm)	Projected BLL* in Children (µg /dL)	Projected BLL* in Adults (µg /dL)
Passion	0.3270+/-0.0009	16.35	9.81
Brown	0.2639+/-0.0002	13.19	7.92
Jasmine	0.2369+/-0.0005	11.84	7.11
Sinandomeng	0.2009+/-0.0003	10.04	6.03
Whole grain	0.2099+/-0.0002	10.49	6.29
Malagkit (violet)	0.3720+/-0.0005	18.6	11.16
Red	0.3270+/-0.0009	16.35	9.81
Malagkit (regular)	0.5160+/-0.0005	25.8	15.48
Dinorado	0.4980+/-0.0008	24.9	14.94
National Food Authority (NFA)	1.4795+/-0.0002	73.98	44.38

*BLL Blood Lead Levels

Table 2. Mean Lead Levels in Fish Meat with Projected Bloods Lead Levels

Fish	Concentration (ppm)	Projected BLL* in Children (µg /dL)	Projected BLL* in Adults (µg /dL)
Hasa-hasa	0.9662+/-0.0011	48.31	28.99
Tilapia	0.6421+/-0.0003	32.11	19.26
Torcilla	0.7141+/-0.0005	35.87	21.42
Tanguigue	0.7501+/-0.0002	37.51	22.50
Dilat	0.8312+/-0.0007	41.56	24.94
Kayabas	0.7501+/-0.0003	37.51	22.50
Galunggong	0.9032+/-0.0007	45.16	27.10
Dalagang Bukid	0.8582+/-0.0003	42.91	25.75
Matambaka	0.8222+/-0.0003	41.11	24.67
Janitor fish	0.7772+/-0.0007	38.86	23.32

*BLL Blood Lead Levels

Table 3. Mean Lead Levels in Fish Head with Projected Blood Leac Levels

Fish	Concentration (ppm)	Projected BLL* in Children (µg /dL)	Projected BLL* in Adults (µg /dL)
Hasa-hasa	2.2988+/-0.0006	114.94	68.96
Tilapia	2.7670+/-0.0018	138.35	83.01
Torcilla	1.1103+/-0.0006	55.52	33.31
Tanguigue	0.8582+/-0.0007	42.91	25.75
Dilat	0.7862+/-0.0011	39.31	23.59
Kayabas	0.6961+/-0.0008	34.81	20.88
Galunggong	12.0230+/-0.0103	601.15	360.07
Dalagang Bukid	0.8492+/-0.0003	42.46	25.48
Matambaka	0.8672+/-0.0005	43.36	26.02
Janitor fish	0.8582+/-0.0015	42.91	25.75

*BLL Blood Lead Levels

Table 4. Mean Lead Levels in Fish Internal Organs with Projected Blood Lead Levels

Fish	Concentration (ppm)	Projected BLL* in Children (µg /dL)	Projected BLL* in Adults (µg /dL)
Hasa-hasa	0.7411+/-0.0005	37.06	22.23
Tilapia	12.6893+/-0.0014	634.46	380.68
Torcilla	0.8492+/-0.0008	42.46	25.48
Tanguigue	2.0737+/-0.0004	103.68	62.21
Dilat	11.4377+/-0.0023	571.88	343.13
Kayabas	0.6781+/-0.0016	33.91	20.34
Galunggong	0.6691+/-0.0005	33.46	20.07
Dalagang Bukid	0.9212+/-0.0002	46.06	27.64
Matambaka	0.9932+/-0.0010	49.66	29.80
Janitor fish	11.283+/-0.0008	564.15	338.49

Table 5. One Way ANOVA for Lead Levels in Different Fish Parts

Source	df	SS	MS	F	P-value
Treatments	2	59.180	29.590	2.2338	0.1265
Error	27	357.657	13.247		
Total	29	416.837			